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Atomic magnetometer-based ultra-sensitive magnetic microscopy

YOUNG JIN KIM, IGOR SAVUKOV, Los Alamos National Laboratory — An atomic magnetometer (AM) based on lasers and alkali-metal vapor cells is currently the most sensitive non-cryogenic magnetic-field sensor. Many applications in neuroscience and other fields require high resolution, high sensitivity magnetic microscopic measurements. In order to meet this need we combined a cm-size spin-exchange relaxation-free AM with a flux guide (FG) to produce an ultra-sensitive FG-AM magnetic microscope. The FG serves to transmit the target magnetic flux to the AM thus enhancing both the sensitivity and resolution for tiny magnetic objects. In this talk, we will describe a prototype FG-AM device and present experimental and numerical tests of its sensitivity and resolution. We also demonstrate that an optimized FG-AM achieves high resolution and high sensitivity sufficient to detect a magnetic field of a single neuron in a few seconds, which would be an important milestone in neuroscience. We anticipate that this unique device can be applied to the detection of a single neuron, the detection of magnetic nano-particles, which in turn are very important for detection of target molecules in national security and medical diagnostics, and non-destructive testing.

Young Jin Kim
Los Alamos National Laboratory

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